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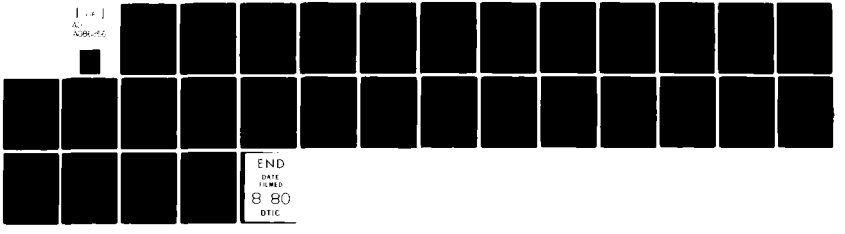

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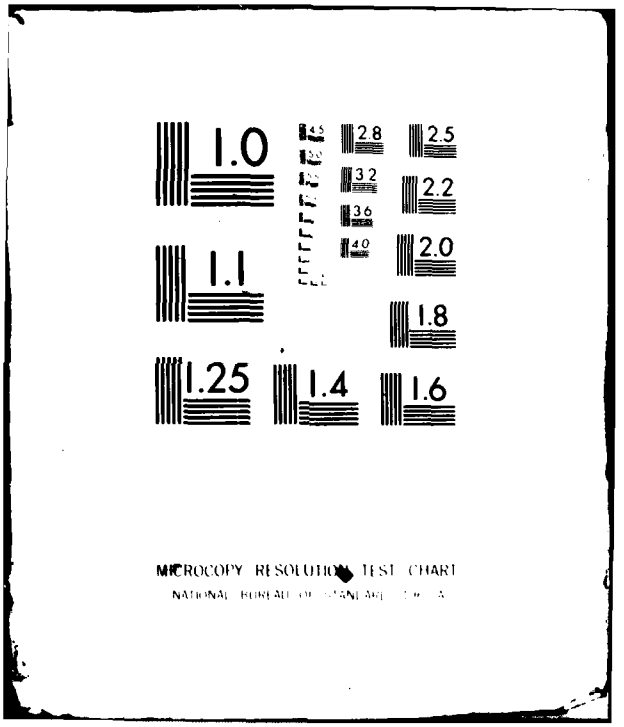
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Report Number 5

MEDICAL ENTOMOLOGY PROJECT

ANNUAL REPORT

Oliver S. Flint, Jr.

January 1980

For the period January 1, 1979 to December 31, 1979

Supported by

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The Medical Entomology Project (MEP), a cooperative venture between the Smithsonian Institution and the U.S. Army Medical Research and Development Command, conducts biosystematic research on arthropods of medical importance to the Army. MEP fulfills this requirement by performing biosystematic studies on important groups of vectors such as anopheline vectors of malaria and culicine vectors of arbovirus diseases, providing information on potential vectors for the guidance of military field research teams and other governmental

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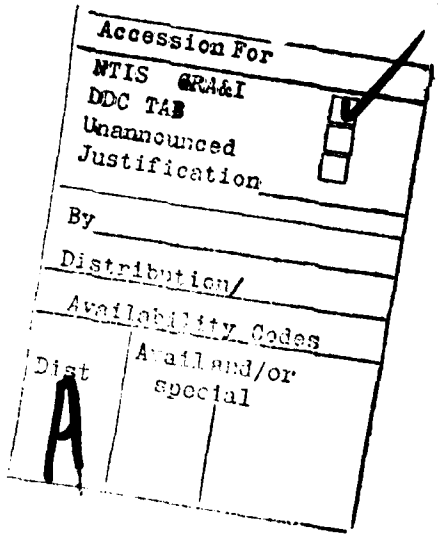
agencies and preparing monographs and technical papers which summarize data on the ecology, taxonomy and medical importance of arthropod vectors in various regions of the world. In addition, MEP performs curation and research on the national collection of mosquitoes at the National Museum of Natural History (USNM), Smithsonian Institution.

Seven short papers on systematics or related subjects, including one each on Oriental and Neotropical *Anopheles*, two on Neotropical *Culex (Melanoconion)* and one on African *Aedes (Stegomyia)* species were published during the year.

Two large monographic revisions were completed and published during the year. These include, the mosquitoes of Japan, Korea and the Ryukyu Islands, and, the intra-subgeneric classification of the subgenus *Stegomyia* of the genus *Aedes* of the Oriental region. A large monograph on the Albimanus section of the subgenus *Nyssorhynchus* of the genus *Anopheles* of the New World was final-typed for offset reproduction and will be published in early 1980. Four additional large monographic revisions have been completed and are awaiting either editing or final typing. These revise the Minimus group of the subgenus *Cellia* of the genus *Anopheles* of Thailand, the Argyritarsis section of the subgenus *Nyssorhynchus* of the genus *Anopheles* of the New World, the Scutellaris group of the genus *Aedes* of Tonga and portions of the genus *Tripteroides* of the Oriental region.

Research continued on the malaria vector groups of the genus *Anopheles* in the New World and the Orient, and on the arbovirus vector groups of the subgenus *Melanoconion*, genus *Culex* in the Neotropical region and the subgenus *Stegomyia*, genus *Aedes* of the African region.



SUMMARY

The Medical Entomology Project (MEP), a cooperative venture between the Smithsonian Institution and the U.S. Army Medical Research and Development Command, conducts biosystematic research on arthropods of medical importance to the Army. MEP fulfills this requirement by performing biosystematic studies on important groups of vectors such as anopheline vectors of malaria and culicine vectors of arbovirus diseases, providing information on potential vectors for the guidance of military field teams and other governmental agencies and preparing monographs and technical papers which summarize data on the ecology, taxonomy and medical importance of arthropod vectors in various regions of the world. In addition, MEP performs curation and research on the national collection of mosquitoes at the National Museum of Natural History (USNM), Smithsonian Institution.

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INTRODUCTION

Biosystematic studies which lead to the precise identification of vectors are fundamental to any investigation of epidemiology and to the planning of control or eradication. They enable the vector or vectors to be recognized; their ecology and habits to be studied and information about vectorial capacity, resistance to insecticides, geographic distribution and so on to be passed on to other workers. Many instances of failure to control diseases resulting from vector borne pathogens can be traced to neglect of this aspect of preventive medicine research.

The Medical Entomology Project (MEP) was developed to perform biosystematic research on medically important arthropods to meet the U.S. Army Medical Research and Development Command's requirements for accurate identification of actual or potential vectors of human pathogens throughout the world. Thus, MEP is able to respond to these needs and the resources of the project are used to accomplish these requirements. This research was accomplished by 14 contract personnel, including 3 professional entomologists, plus the principal investigator and 2 professional entomologists from Walter Reed Institute of Research (WRAIR) on assignment to MEP. In addition, upon request, MEP provides synoptic collections of specimens for the use of various military entomologists and assists them in biosystematic studies of medically important arthropods. This level of support may range from furnishing entomologists with keys, necessary literature, and other identification guides to the loan of specialized collecting and rearing equipment which cannot be obtained from other sources. Such support has proven invaluable to all concerned, as the Smithsonian Institution has received extremely worthwhile material from these entomologists.

REVIEW OF PROGRESS FOR THE PERIOD
1 January to 31 December 1979

1. Biosystematic Studies on Culicidae

a. Genus *Anopheles*

(1) Subgenus *Cellia* (Leucosphyrus group) of the Oriental region

(E.L. Peyton)

Work continued on the revision of the Leucosphyrus group with greatest emphasis on resolving problems within the Balabacensis complex, which is now known to consist of at least 8 recognizable forms, some of which are undescribed. All of these are extremely similar in morphological features in one or more life stages, and those stages which exhibit some differences have sufficient variation to show some degree of overlap, frequently resulting in only statistical differences. The group appears to be a classical example of a "sibling species" complex. Nevertheless, with the very large diverse study sample available of most forms for morphological analysis and the collaborative efforts of the U.S. Army Medical Component, AFRIMS, Bangkok, Thailand on cytogenetics, electrophoresis and cross mating studies, the systematic status of 2 important forms previously recognized as *balabacensis* has been determined and others are in various stages of confirmation. Considerable preliminary morphological data has been assembled on these remaining forms but the laboratory supportive studies in Bangkok are still in progress.

In collaboration with MAJ Bruce A. Harrison of the AFRIMS, Bangkok, the widely distributed Thailand form of *balabacensis*, refered to in last year's report and the "Chonburi form" was named *dirus* Peyton and Harrison and fully described and illustrated in a publication in "Mosquito Systematics" in March 1979. In view of the variable nature of this species, the close similarity to *balabacensis* and the extreme popularity of the name *balabacensis* among workers in Thailand and elsewhere, this publication has met with considerable skepticism in the region. However, subsequent cytogenetic and cross mating studies, which will be published separately in the near future, have confirmed this taxonomic decision.

A joint manuscript with MAJ Harrison on the Taiwan form of *balabacensis* is in preparation and will appear in mid-1980. The specific status of this form has been determined on the basis of morphological and laboratory studies. This paper will include a complete morphological description and data on cross mating studies. Cytogenetic and

electrophoretic findings will be published separately at a later date. Fortunately, we were able to obtain eggs of this form from the NAMRU-2 colony in Taiwan early in 1979, before that unit ceased operation. A colony was successfully established in Bangkok where the laboratory studies were carried out. Approximately 60 adults and a like number of slides of larval and pupal skins were received from this colony and compared with field collected material in the MEP collection.

A total of 1,904 adults and 1,649 slides of whole larvae and larval and/or pupal skins of the Leucosphyrus group were received from the AFRIMS laboratory during the year. A portion of these were progeny broods from laboratory colonies and the remainder consisted of individually reared field collected material of adults with associated skins and progeny broods from several areas of Thailand. All of this material has been closely examined. Most of this material was the more common *dirus* but of particular interest were specimens from southern peninsular Thailand. The Perlis form is known from northwestern Malaya but its extension north into Thailand is unknown. It had been assumed that the northern limits of the Perlis form and the southern limits of *dirus* occurred somewhere very near the Thai-Malay border where the two forms should meet. Although we have never been quite certain of the proper taxonomic status of the Perlis form we have for some time been able to recognize it on morphological and behavioral characteristics. In areas where only one or the other of the two forms are known to occur each is easily recognized in the pupal stage. However, from a single progeny brood consisting of 60 reared adults with associated skins from a female collected in southern Thailand between Chumphon and Ranong (Isthmus of Kra), and based on the main pupal character used to separate the 2 forms there were 19 with typical *dirus* character, 31 with typical Perlis character and 10 intermediates not clearly assignable to either. All of several other progeny broods and field collected and reared material from this area were typical *dirus*. We have not yet reached a consensus on the significance of this single observation. Although this finding is suggestive of a number of possibilities we feel it is insufficient to rush to any definite conclusion at this point. Colonies of both forms have been established in Bangkok for over one year and laboratory studies of these two on cytogenetics, electrophoresis and cross mating are well advanced. In addition a large collection of field collected and reared material including progeny broods collected earlier in the year from the area of Phangnga about 225 kilometers south of the Isthmus have been processed at the AFRIMS laboratory and were shipped to MEP in December 1979. If hybridization is occuring in this region this collection will hopefully shed further light on the question.

In addition to the above, MAJ Harrison sent a significant collection of 62 adults and 44 slides of immature stages, consisting of 28 adults

of *balabacensis* and 2 adults of *leucosphyrus* from Sabah, Borneo, 31 adults of the typical Fraser's Hill form and 1 adult of *balabacensis introlatus* from Phahang, Malaya which he borrowed from Dr. Shivaji Ramalingam of the University of Malaysia. All of this material was also studied. The acquisition of a critical topotypic collection of the Malayan Fraser's Hill form has helped to resolve the question of the remaining unnamed form found in several parts of Thailand. After examining this new material I now feel that the Malay-Thai forms are conspecific and represent a distinct unnamed species. This form will be treated in a separate paper jointly authored with MAJ Harrison and Dr. Ramalingam during 1980.

A small collection of 30 field reared adults with associated larval and pupal skins of *balabacensis* sensu stricto were donated to MEP by the London School of Hygiene and Tropical Medicine. These specimens were recently collected in Sabah, Borneo. They were critically examined and found to compare very favorably with the preliminary description of the species included in the March 1979 paper describing *dirus*.

Examination of a very large collection of approximately 500 slides of larvae and larval and/or pupal skins from Bangladesh was completed. These all proved to be the same as the new species *dirus* described from Thailand. With all of the major collections from mainland Southeast Asia now examined, it seems clear that *balabacensis balabacensis* does not occur on the mainland and that the dominant form encountered throughout most of the mainland north of Peninsular Malaysia is *dirus* and that this species is a primary vector of malaria in many parts of this region.

During the report period setal counts, measurements and ratios of various larval and pupal characters were made on several species not previously analyzed and others were made to extend the sample size of previous studies. Similar analyses were made on adult characters in preparation for descriptions in the two papers published or in preparation. Preliminary pencil drawings of various stages of additional species are continuing.

A short paper describing the immature stages of *Uranotaenia (Pseudoficalbia) srilankensis* in collaboration with specialists of the Department of Entomology, Medical Research Institute, Colombo, Sri Lanka was prepared and published during the year.

In addition to the above studies this investigator critically reviewed 9 manuscripts written by other investigators, including the large 400+ page monograph on the *Anopheles*, Minimus group of Thailand.

(2) Subgenus *Anopheles* (Arribalzagia group) of the Neotropical region

(K. Bryce)

During the report period work continued on a revision of the Arribalzagia group of the subgenus *Anopheles*. This revision will include the following species: *apicimacula, gabaldoni, intermedius, mattogrossensis, mediopunctatus, minor, neomaculipalpus, peryassui, punctimacula, shannoni* and *vestitipennis*. It will also include a discussion of the recently described *veruslanei* Vargas, 1979. These species will be considered in this revision since there is at least some material available and because of the medical importance of some of these species.

To date all material from 4 major sources has been examined. The bulk of the material is contained in the UCLA collection. This includes approximately 2,300 pinned adults and 800 mounted whole larvae, larval exuviae, pupal exuviae and male genitalia. Included in this material are the only individual rearings which have been available, these numbering 170. Secondly is a collection of material from the USNM, which was selected during a visit to MEP in November 1978. It consists of approximately 1,000 pinned adults, most of which are in poor condition. Thirdly is a small sample of approximately 50 pinned adults provided by Mr. J. Lane of the London School of Hygiene and Tropical Medicine. This material was important in that it contained specimens which were probably from the same series from which Vargas described *veruslanei*. And finally are the holotypes deposited at the USNM. This group consists of the following nominal species: *apicimacula, celidopus, fluminensis, malefactor, punctimacula, shannoni* and *vestitipennis*. These holotypes were borrowed from the USNM and examined at UCLA this last year.

Because of the small number of individual rearings which are available this revision must be considered preliminary at best. Specimens are available from very few populations. As such it is difficult to accurately assess the range of variation of characters within many of the species. In spite of these limitations certain clarifications and taxonomic decisions will be made.

At present, no new taxa will be described from this group. While there are specimens which do not seem to belong with any of the recognized species, there is not sufficient material to warrant the introduction of additional poorly characterized taxa to this already confused group.

Considerable time was devoted to working on the *apicimacula-intermedius* complex. These species, along with *gabaldoni* and *vestitipennis*, form a closely related complex within the Arribalzagia group and have caused considerable confusion. This confusion was compounded by the description of *veruslanei* by Vargas in 1979. At this time it is believed that individuals of the species *intermedius* are restricted to the northeastern coastal region of South America and do not extend into Central America as has been frequently reported. The specimens of "*intermedius*" from Central America appear to be *apicimacula*. *Anopheles apicimacula* seems to be a wide ranging polytypic species, occurring throughout Central America. After examining the material provided by Mr. J. Lane, the species Vargas described as *veruslanei* appears to be one of the forms of *apicimacula*. However, just from Vargas' description, this could also be the species *vestitipennis*.

At present, a manuscript is being written on the group. Much of the introductory material as well as species descriptions for the larvae of all the species considered have been completed. Based on the delays encountered, it is difficult to predict a date for completion of this revision. Contract support for this study terminated 31 December 1979. The Medical Entomology Project expects to assist with the publication of the final monograph when it is completed.

(3) Subgenus *Nyssorhynchus* of the Neotropical region

(M.E. Faran)

(a) The final draft of the revision of the Albimanus Section of the subgenus *Nyssorhynchus* has been typed, edited and reviewed for publication which is scheduled early in 1980. This monograph is 214 pages in length and includes 33 illustrations. It is based on the study of 14,784 specimens: 2,819 males, 785 male genitalia, 6,118 females, 2,072 pupae and 2,990 larvae, including 1,664 individual rearings (749 larval, 734 pupal, 181 incomplete) and 30 progeny rearings. In conjunction with this revision, a new species, *Anopheles (Nyssorhynchus) trinkae* Faran 1979, a possible vector of malaria in Ecuador, was described in the March 1979 issue of "Mosquito Systematics."

(b) Research has continued on the handbook (funded by WRAIR and jointly authored by M. E. Faran and K. J. Linthicum) on the species of *Nyssorhynchus* occurring in the Amazon Basin, which is scheduled to be published in 1980 in "Mosquito Systematics." This handbook will include keys to females, male genitalia and larvae of 14 species of *Nyssorhynchus* in the Amazon. Approximately 140 illustrations will be included in the keys to facilitate identification of the numerous morphologically

similar species in this subgenus. In addition, there is a brief discussion of the bionomics, medical importance and distribution of each species. It is anticipated that the final manuscript will be about 120 pages in length. Specimens used for this study were made available through the Medical Entomology Project.

(4) Subgenus *Nyssorhynchus* (Argyritarsis section) of the Neotropical region

(K.J. Linthicum)

Research was continued and completed on the revision of the Argyritarsis Section at the Walter Reed Army Institute of Research using the collections available at the National Museum of Natural History, Smithsonian Institution and the Rozeboom collection at Johns Hopkins University School of Hygiene and Public Health. Approximately 300 specimens have been examined in detail from these two collections and many of these specimens were from localities not previously examined. All distribution and collection record information for the approximately 9,000 specimens examined in the revision have been incorporated into the final draft. The final editing of the revision is now in progress by Dr. J. N. Belkin. Contract support was not provided this study during the past year, but the original research on this group was supported by MEP and the publication of the monograph will be funded through the contract.

b. Genus *Culex*, subgenus *Melanoconion* of the Neotropical region

(S. Sirivanakarn)

Significant progress on several aspects of taxonomy and nomenclature has been made in the revisionary study of the Ocossa and Spissipes (formerly reported as Taeniopus) groups. Two papers describing the new species *lopesi* Sirivanakarn and Jakob, and *penai* Sirivanakarn were published during 1979. Three more papers treating taxonomic and nomenclatorial problems in the Spissipes group are now being edited for publication in "Mosquito Systematics," in early 1980. In the first paper with Dr. J. N. Belkin as co-author, corrections and taxonomic changes are made in the interpretation of the following nominal taxa: *opisthopus* is synonymized with *taeniopus*, *pseudotaeniopus* is synonymized with *epanastasis*, *crybda* is considered valid and is resurrected from synonymy of *epanastasis* and a new species is described for the Panamanian population previously referred to as "*taeniopus*." In the second paper, a new species related to *crybda* and

epanastasis is described in collaboration with Dr. Pedro Galindo for the Panamanian form previously recorded as "type G" (Galindo 1969, Mosq. Syst. Newslett. 1: 82-9). The third paper, co-authored with Dr. N. Degallier, who provided topotypic reared specimens of *portesi* from French Guiana, deals with the synonymy of *cayennensis* with *portesi*, description of all stages of this species, neotype designation in *portesi* and lectotype selection for *cayennensis*.

As a result of the above collaborative studies, the Spissipes group as recognized by Galindo (1969) is redefined to include the following valid nominal taxa: *spissipes*, *taeniopus*, new species Sirivanakarn and Belkin, *crybda*, new species Sirivanakarn and Galindo, *epanastasis*, *vomerifer*, *portesi*, *paracrybda*, *delpontei*, *faurani* and *lopesi*. In addition, there are 2 other members: *chrysothorax* and one new Brazilian form related to *vomerifer* of the Spissipes group which will be included in the revision when additional topotypic material from Brazil is available.

In preparing preliminary drafts for a combined revision of the Ocossa and Spissipes groups, the following aspects of the work were accomplished: accumulation and analysis of detailed morphological data of all known stages (adults of both sexes, associated pupal and larval exuviae) of 16 species (2 in Ocossa group, 14 in Spissipes group); preparation of preliminary keys to groups, subgroups and species; preparation of a draft on group characters and a detailed scheme of classification of the Spissipes group into various subgroups or complexes. Currently, descriptions of all known stages of 5 species are completed with a summary of the available data on the bionomics, medical importance and distribution. The final drawings of the adults, male genitalia, female cibarial armatures, pupal and larval chaetotaxy of the following species were completed: *ocossa, panocossa, taeniopus, paracrybda, pereyrai, crybda, lopesi* and 2 new species. To supplement conventional line drawings, several electron micrographs showing details of vestiture of the adults of *ocossa*, *spissipes* and *taeniopus* were prepared and will also be used to accompany verbal description in the text.

Through the courtesy of Dr. A. J. Shelley, the type-specimens of *Cx. lugens* and a female labelled as *chrysothorax* at the Institute of Oswaldo Cruz, Brazil were obtained for examination. The *chrysothorax* specimen was found to be different from the original description in the absence of tarsal markings, indicating that it probably represents a species distinct from *chrysothorax*. Since the latter is unquestionably a member of the Spissipes group, an attempt should be made to examine the holotype male at the Institute of Oswaldo Cruz during this revisionary study.

Mr. J. Haeger of Florida Medical Entomology Laboratory, Vero Beach, has deposited in the USNM 133 pinned adults of the following *Melanoconion* species from Florida; *taeniopus, iolambdis, peccator, erraticus, mulrennani, pilosus* and *atratus.*

c. Genus *Aedes*, subgenus *Stegomyia*

(Y.-M. Huang)

(1) Subgenus *Stegomyia* of the Oriental region and the South Pacific

A monograph, "The subgenus *Stegomyia* of *Aedes* of the Oriental region with keys to the species" was published during July 1979.

The manuscript with illustrations "A revision of the *Aedes* Scutellaris group on Tonga" has been critically reviewed by 2 external specialists. It is anticipated that this monograph will be published during 1980.

(2) Subgenus *Stegomyia* of the African region

The biosystematic studies of the subgenus *Stegomyia* of Africa concentrated on the Simpsoni complex and closely related species. A detailed study of the type-specimens of *simpsoni, lilii, bromeliae* and other available material from the African region was completed and a taxonomic paper dealing with the Simpsoni complex was published in September 1979. In this paper, a lectotype female for *Aedes (Stegomyia) simpsoni* is designated, fully described and illustrated. Diagnostic characters for recognizing *simpsoni, lilii* and *bromeliae* females are presented. Characters for separating the Simpsoni complex from other African *Stegomyia* are also given. It is hoped that this paper will stimulate further investigations on the ecology, behavior and transmission of yellow fever of each of these 3 forms in various areas of Africa. It is also hoped that this paper will encourage workers to collect more material for study so that further reliable diagnostic characters can be found to separate these species in all stages and to better define the limits of distribution of each.

During the course of this work more than 452 specimens (including 151 terminalia) were examined and some 40 rather important literature references relating to *simpsoni* were reviewed. Special effort was made to analyze and evaluate the characters of such highly variable species as *simpsoni, bromeliae* and closely related species. Morphological differences exhibited in the adult stage of "*simpsoni*"

as previously defined suggests a complex, consisting of several closely related, variable species. Thus, a large number of individually reared specimens with associated larval and pupal skins, as well as specimens of progeny rearings from single adult females from many different localities will be necessary to resolve the taxonomic status of the various species of this complex.

A manuscript with illustrations on a new species of African *Stegomyia* closely related to the Simpsoni complex has been completed. The female was taken biting man in the bush, in Kenya, along with females of the Simpsoni complex and *woodi* Edwards. This paper will be submitted for publication in "Mosquito Systematics" during 1980.

In addition, a preliminary study of the following species, related to the Simpsoni complex was completed: *kivuensis, strelitziae, subargenteus* and *woodi*.

Research has begun on the Masseyi-Keniensis, Demeilloni, and Pseudonigeria complexes. Some taxonomic problems related to these species cannot be resolved until the specimens in the Division of Vector-Borne Diseases, Ministry of Health, Nairobi, Kenya and the South African Institute for Medical Research in Johannesburg, South Africa are examined. This material will be examined during a visit to these institutions in early 1980.

A pictorial key to the mosquito vectors of yellow fever in Africa was prepared in order to assist field workers in recognizing the vector species in the area. This key was developed in response to a World Health Organization (WHO) invitation to conduct a training course "Taxonomy of Yellow Fever Vectors" for WHO regional entomologists from 10 African countries, in the National Arbovirus Unit, Enugu, Nigeria. A total of 13 species: 1 *Eretmapodites* and 12 *Aedes* (2 *Aedimorphus*, 2 *Diceromyia* and 8 *Stegomyia*) are included in the key and other morphological features of mosquitoes used in identification are also covered. In this short-term training course, the techniques of field collecting, laboratory rearing and the preparation of specimens for taxonomic studies are to be covered.

It is anticipated that following this training course, at least some, if not all, of the trainees after returning to their respective countries will send additional specimens to the Medical Entomology Project for confirmation or further study.

Considerable effort has been devoted to preparations for an extended trip to Africa from 1 January 1980 through 29 March 1980. This trip will accomplish several objectives in 3 different African

countries and is outlined in greater detail elsewhere in this report.

During the year new material consisting of 181 adults (including 21 individual rearings with associated larval and pupal skins) of African *Stegomyia* were acquired from the following sources: (1) 84 adults, (Central African Republic), from Dr. A. Rickenbach, ORSTOM, Bondy, France; (2) 15 adults, 13 larval and pupal skins and 9 whole larvae, (Kenya), from Dr. L. P. Lounibos, Florida Medical Entomology Laboratory, University of Florida, Vero Beach; (3) 6 adults, 1 terminalia slide, and 6 larval slides, (Angola), from Prof. H. Ribeiro and Dr. H. da Cunha Ramos, Cadeira de Entomologia, Instituto de Higiene e Medicina Tropical, Lisboa, Portugal; (4) 36 adults, (Liberia), from Ms. M. K. Thayer, Museum of Comparative Zoology, Harvard University, Cambridge, Massachusetts; (5) 40 adults, 8 larval and pupal skins, and 32 pupal skins, (Nigeria), from Dr. A. B. Knudsen, WHO VBCRU-I, Enugu, sub-unit, Nigeria.

Seven lots of eggs, (South Africa), from Dr. C. A. Green and Mr. J. Muspratt, SAIMR, South Africa, were received and hatched at MEP. Individual progeny rearings were carried out and the adult specimens with their associated larval and pupal skins were prepared at MEP for taxonomic studies. A total of 83 adults, 53 larval and pupal skins and 28 pupal skins were obtained by this method during this year.

2. Field Studies.

a. Brazil

A field trip (supported by WRAIR) to Brazil by M.E. Faran was made from 15 May - 15 July 1979 for the purpose of consulting on systematic problems involving the principal vectors of malaria in Brazil, which included the training of technicians in the collection and rearing of mosquitoes, and preparation for taxonomic research. A total of 2,494 specimens were collected; 572 individual rearings (308 larval, 181 pupal, 83 incomplete), 40 adults and 481 larvae. It is anticipated that MEP will receive about 50% of this material, currently being prepared by USAMRU-Brasilia. This material has not yet been carefully examined; however, tentatively identified are the following species or species groups: *Anopheles (Ano.) mediopunctatus, An. (Ano.) sp., An. (Nys.) darlingi, An. (Nys.) allopha, An. (Nys.) argyritarsis, An. (Nys.) braziliensis, An. (Nys.) lanei, An. (Nys.) strodei, An. (Nys.) nuneztovari, An. (Nys.) oswaldoi, Aedes (Ochlerotatus) sp., Culex (Culex) sp., Cx. (Melanoconion) sp., Cx. (Microculex) sp., Limatus sp., Psorophora (Psorophora) sp., Ps. (Janthinosoma) sp., Sabethes sp.* and *Toxorhynchites sp.*

b. Africa

Dr. Yiau-Min Huang will participate in a combined African Museum, field study and training trip from January 1 - March 29, 1980 to accomplish the following objectives: (1) to study type-specimens and other important existing material of African *Stegomyia* at the Division of Vector-Borne Diseases, Ministry of Health, Nairobi, Kenya and at the South African Institute for Medical Research in Johannesburg, South Africa; (2) to undertake extensive field studies in at least 4 widely separated localities within South Africa, collecting and individually rearing topotypic and other critical material, obtaining biological and ecological information with primary emphasis on *Aedes (Stegomyia)* species and secondarily on species of *Anopheles*; (3) participating in a one week training course for WHO regional entomologists, sponsored by WHO at the National Arbovirus Unit, Enugu, Nigeria without cost to the MEP contract.

3. Curatorial Activities.

a. Status of world collection of Culicidae.

During the year a major effort to improve the curatorial status of the collections has continued. Amalgamation of the J. N. Belkin, CDC and "Excess" collections with the existing museum collection was completed through the genus *Culex*. Approximately 36,000 specimens were rearranged into new unit trays. Work on this section of the collection has been temporarily suspended due to a shortage of museum drawers. Incorporation of material stored in Schmidt boxes into museum drawers has continued, with approximately 10,000 specimens being transferred during the year.

b. Contract collectors.

Mr. B. Mohan of Coonoor, southwest India made a brief trip on our behalf to Mudigere in an attempt to collect critical material of the Leucosphyrus group. Unfortunately, the seasonal timing of this trip was apparently wrong and the trip failed to produce any specimens of the group although *balabacensis* is reported from the area. We obtained a small number of specimens of other species collected incidental to the concentrated search for Leucosphyrus. Mr. Mohan has collected off and on for MEP for several years and through his efforts the project has assembled a very significant collection of mosquitoes from the Nilgiri Hills of southwest India. Approximately 3 months after making the trip to Mudigere, Mr. Mohan died. At the time of his death Mr. Mohan was preparing a collection of specimens from the Coonoor area for shipment to MEP. His son has indicated through recent correspondence that he will complete the shipment of this material. Over the years MEP specialists have named 2 new species of Indian mosquitoes after

B. N. Mohan in recognition of his efforts.

c. Accessions and other activities of the MEP collections management section.

The 57 accessions received by MEP are summarized in Appendix 1. During 1979 these totaled 7,060 specimens.

Dr. Mattingly of the British Museum (Natural History) arranged for the shipment of 475 pill boxes of Culicidae from the old "Congo." To date, 91 boxes have been examined and 601 specimens judged to be of sufficient quality to have been saved and mounted. This collection should provide much needed material from this poorly known area of Africa.

Outgoing material involving specimens (loans, return of borrowed material, etc.), accounted for 4,172 specimens in 47 transactions. In addition 6,500 specimens on long term loan from several institutions were assembled labeled and packed for return in January 1980.

4. Other Activities.

a. Identification services.

In keeping with the stated duties of MEP, the staff made, or arranged to have made numerous identifications of material from outside sources. A few of these transactions involved small lots of mosquitoes and other insects. However, a few major lots were handled during the year.

In response to requests from the Center for Disease Control, U. S. Public Health Service, Ft. Collins, Colorado and Cornell University, Dr. Sirivanakarn identified about 150 field collected adults of *Melanoconion* and other New World *Culex* from Brazil, Argentina, Guatemala and Florida. The species identified for these organizations include: *Cx. (Mel.) vomerifer, crybda, taeniopus, pilosus, panocosa, erraticus, iolamdis; Cx. (Mic.) reducens, imitator, inimitabilis, aphylectus; Cx. (Cux.) nigripalpus, salinarius, coronator, virgultus, corniger* and *quinquefasciatus*. There were a few other *Melanoconion* species which could not be identified and were retained for further study.

Dr. Huang identified approximately 44 specimens of *Aedes* from the Republic of Korea, San Mateo, California and Kenya for the following individuals and organizations: CPT A. N. Hunt, 5th Preventive Medicine Unit, Korea, Dr. L. T. Hui, Vector Biology and Control Section, Department of Health, State of California and Dr. L. P. Lounibos, Florida Medical Entomology Laboratory, University of Florida.

b. Publications.

Seven short papers and two large monographic revisions were published during the year (appendix 2).

In the Annual Report Number 3 it was mentioned that the draft manuscript on the mosquitoes of Japan, Korea and the Ryukyus had been received from Dr. Kazuo Tanaka, formerly of the U. S. Army Medical Laboratory (Pacific). This draft was considered to be the final report of that organization and was turned over to MEP for publication from the USAMRDC. The 1,005 page manuscript required extensive revision and editing. New sections on bionomics were prepared by MAJ Edward S. Saugstad of Fort Meade, Maryland. In addition, over 225 of the 262 full-page plates required modification by MEP illustrators. The revised, edited manuscript was submitted to the printer in September 1979 and the final publication of 987 pages was issued in December 1979 as Volume 16 of the "Contributions of the American Entomological Institute." Since the scope of this publication has not been previously detailed, an abstract of this monograph is given below.

This is a taxonomic revision of the adults and 4th larval stage of the true mosquitoes of Japan including the Ryukyu Archipelago and the Ogasawara Islands, and South Korea. The pupa is only briefly considered in the subfamily Anophelinae. The family Culicidae is divided into 2 subfamilies: Anophelinae and Culicinae. The subfamily Culicinae comprises 4 tribes: Culicine, Uranotaeniini, Sabethini and Toxorhynchitini. No changes are made to the generic and subgeneric divisions. *Culex (Barraudius) inatomii* is elevated to species rank from a subspecies of *modestus*. *Toxorhynchites (Toxorhynchites) yamadai* and *Tx. (Tox.) yaeyamae* are reduced to subspecies of *manicatus*. New taxa are as follows: *Culex (Eumelanomyia) hayashii ryukyuanus* new subspecies, *Cx. (Lutzia) shinonagai* new species, *Heizmannia kana* new species, *Aedes (Ochlerotatus) impiger daisetsuzanus* new subspecies, *Ae. (Och.) hexodontus hookaidensis* new subspecies, *Ae. (Finlaya) japonicus amamiensis* new subspecies, *Ae. (Fin.) japonicus yaeyamensis* new subspecies *Ae. (Fin.) nishikawai* new species, *Ae. (Stegomyia) flavopictus miyarai* new subspecies, *Ae. (Stg.) wadai* new species, *Uranotaenia (Pseudoficalbia) novobscura ryukyuana* new subspecies and *Tripteroides (Tripteroides) bambusa yaeyamensis* new subspecies. The male of *Anopheles (Anopheles) saperoi saperoi* and the larva of *Aedes (Geoskusea) baisasi* are described for the first time.

The bionomics and relation to diseases, when known, are briefly discussed for each species. The morphology of the larval maxilla is discussed, and the following new terms are proposed: lacinal suture, lateral artis, mesostipes, palpostipes, pseudoartis and stipital sensorium. In addition, a new numbering system for the maxillary ring-based setae is presented.

c. Illustrations.

The scientific illustrator staff continued to provide illustrative support to a wide variety of studies including work on *Anopheles*, *Culex*, *Aedes*, *Tripteroides*, the Mosquitoes of Japan and Korea and the Taxonomic Glossary. These included completed illustrations for short articles published during the year and penciled preliminary and inked final drawings for the larger monographic works. All illustrative requirements were completed for the Mosquitoes of Japan and Korea, the revision of the *Tripteroides* and the Taxonomic Glossary.

d. Scientific Literature.

Approximately 500 folders were typed and filed during the year. Continuing our long established tradition, several cartons of duplicate reprints were sent to the Defense Pest Management Information Analysis Center, Armed Forces Pest Management Board for inclusion in their files.

Several references on *Toxorhynchites* were furnished to Dr. W. A. Steffan. Dr. Steffan also visited the project for a few days during the summer and made copies of many references from the MEP file. Selected references were also provided to MEP collaborating specialists and institutions and in particular the AFRIMS laboratory in Bangkok and MAJ A. Bosworth, Dept. of Entomology, Texas A & M University.

e. Participation in scientific activities.

The MEP staff entomologists attended the annual meeting of the American Mosquito Control Association held in Washington, D. C. from 8-12 April 1979.

Mr. E. L. Peyton served on the registration Committee for the American Mosquito Control Association meetings and at the invitation of the President of the Gorgas Memorial Institute (GMI), Mr. Peyton attended the annual business meeting of the GMI in Washington, D. C. on 31 January 1979. In addition, Mr. Peyton attended 2 presentations on field studies in Brazil held at the Walter Reed Institute of Research.

Dr. M. E. Faran participated in a symposium "A Multidisciplinary or Holistic Approach to Mosquito Systematics" which was held in April and a paper was delivered on the importance of this approach which was published in the December 1979 issue of "Mosquito Systematics." Three other papers were delivered at scientific meetings: (1) The importance of immatures in the systematics of species complexes of mosquitoes (Diptera, Culicidae) at Eastern Branch Entomological Society of America

and (2) Isolation of Keystone virus from *Aedes infirmatus* in the Chincoteague National Wildlife Refuge, Virginia, meeting of American Society of Tropical Medicine and Hygiene (junior author) and (3) Winter survival and ovarian development of *Culex pipiens*, meeting of American Society of Tropical Medicine and Hygiene (junior author). His travel was conducted at no expense to the Project.

f. Visitors.

During the year, 48 visitors signed the guest book in the project. Overseas visitors included Dr. John Ledger (South African Institute for Medical Research, Johannesburg), Mr. Norman Peterson (PAHO, Belem, Brazil), Rev. Enrique Schoenig (University of San Carlos, Cebu, Philippines), Dr. Christine Dahl (University of Lund, Sweden), Dr. Richard F. Darsie, Jr. (San Salvador, El Salvador), Dr. Donald J. Pletsch (Mexico, Mexico), Dr. W. A. Steffan (Bishop Museum, Honolulu, Hawaii), Dr. Roy S. Panday (Paramaribo, Surinam), Dr. Peter Belton (Simon Fraser University, B. C., Canada), Dr. Osamu Suenaga (Nagasaki University, Japan), Dr. T. Shelly (Oswaldo Cruz Institute, Brazil), Dr. R. A. Ronderos (Museo de La Plata, Argentina), Dr. Jack Peterson (Gorgas Memorial Laboratory, Panama), Dr. I. E. Mukuaya (Virus Research Institute, Uganda), Ms. P. Graves (Ross Institute, London), Mr. W. H. Cheong (Institute for Medical Research, Kuala Lumpur, Malaysia), Ms. Rose Tarimo (Tanzania) and Dr. H. R. Bhat (National Institute of Virology, Pune, India).

Dr. William E. Bickley (University of Maryland) has continued working in the project a few days each week identifying and curating North American mosquitoes of the genera *Culiseta* and *Psorophora*.

Dr. Richard Darsie visited the project for a few days to check the larvae of certain North American mosquitoes for use in the project on keys to the mosquitoes of North America, north of Mexico which is a joint project of Drs. Darsie and Ward (WRAIR) and is funded by the American Mosquito Control Association.

Dr. Christine Dahl (University of Lund, Sweden) spent one week in the project examining specimens of the black-legged Holarctic *Aedes*.

g. Consultants.

The consultants of the MEP are identified in Appendix 3.

Dr. Peter F. Mattingly completed his study of the genus *Tripteroides*. A draft manuscript dealing with approximately 30 species from

the Oriental region will be reviewed at MEP during the coming year. This large monographic revision should be ready for publication in early 1981.

MAJ Bruce A. Harrison is making final minor editorial corrections to his manuscript on the *Anopheles (Cellia)*, Minimus group of Thailand. Final typing for offset reproduction should begin early in 1980.

Drs. Ralph E. Harbach and Kenneth L. Knight have completed the production of "A Mosquito Taxonomic Glossary." Publication is expected in 1980. The MEP provided a few small illustrative requirements during the report period and in earlier years of this study provided most of the illustrations. Dr. Kenneth L. Knight visited the project in April to discuss aspects of the Glossary with MEP staff.

Dr. J. N. Belkin consulted with the MEP staff on a wide range of problems of mutual interest during a visit from 23-25 October 1979.

5. Recommendations

Acquisition of new material from poorly collected regions or countries of the world continued to be a primary concern of the project. Various means are used to obtain critical material needed to complete studies including loans and gifts from numerous institutions and individuals. However, we continue to stress that there is no substitute for the quality and quantity of the material that our own professional staff can generate on a well supported field trip. Such a trip is scheduled for South Africa for early 1980. Advanced planning, funding and in-country contacts for this well developed trip took approximately 2 years. However, at a very late date the World Health Organization extended an invitation to our specialist to combine an 8 day stopover in Nigeria to participate in a training course and some collecting at their expense. We have accepted this invitation and obtained the necessary permission to do so.

Since invitations to join others often develop very suddenly, advanced budgets cannot be prepared. However, if we are allowed to take advantage of such offers when they develop, a substantial cost saving can result.

In light of our continuing need for quality material, especially from Africa, it is recommended that field collecting by the professional staff be considered as an essential part of the overall program, consistent with the funds available for each contract year and that fullest advantage should be made of offers by other agencies to share all or part of the cost of such trips.

ACCESSIONS OF THE MEDICAL ENTOMOLOGY PROJECT, 1979

Source	Number of Accessions	Adults	Slides	Other
SEATO Medical Research Lab. Bangkok, Thailand	5	1904	1649	0
WRAIR Washington, D. C.	2	995	0	995 Unmounted Immatures
Florida Medical Entomology Lab. Vero Beach, Florida	1	135	0	137 Unmounted Adults
N.M.N.H. Washington, D. C.	6	231	0	0
C.D.C. Ft. Collins, Colorado	3	117	66	0
D. J. Pletsch Mexico, D. F., Mexico	1	85	0	0
O.R.S.T.O.M. Bondy, France	1	84	0	0
Cornell University Ithaca, New York	1	53	0	0
A. B. Knudsen Nigeria	1	40	0	40 Unmounted Immatures

Source	Number of Accessions	Adults	Slides	Other
Museum of Comp. Zoology Cambridge, Massachusetts	1	36	0	0
Medical Research Institute Colombo, Sri Lanka	1	35	0	35 Unmounted Immatures
L.S.H.T.M. London, England	1	30	0	30 Unmounted Immatures
B. N. Mohan Coonoor, India	1	29	0	33 Unmounted Immatures
U.S. Army MEDDAC CZ. APO Miami 34008	1	19	0	20 Unmounted Immatures
U.C.L.A. Los Angeles, California	2	18	2	6 Unmounted Immatures
British Museum London, England	3	18	0	0
University of the Ryukyus Okinawa, Japan	1	16	11	0
University of Minnesota St. Paul, Minnesota	1	16	0	0
ICIPE Mombasa, Kenya	1	14	0	34 Unmounted Immatures

Source	Number of Accessions	Adults	Slides	Other
University of Ife Ile-Ife, Nigeria	1	8	0	0
USDA Gulf Coast Mosq. Res. Lake Charles, Louisiana	2	7	4	0
Inst. de Higiene e Medicina Tropical Lisbon, Portugal	1	6	7	0
National Park Service Triangle, Virginia	1	6	0	0
Tuskegee Institute Tuskegee, Alabama	1	5	0	0
5th Preventive Med. Unit APO San Francisco 96301	1	2	2	0
Anonymous Washington, D. C.	1	2	0	0
University of Arizona Tuscon, Arizona	1	1	0	0
O.R.S.T.O.M. Cayenne, French Guianna	1	0	16	0
Thomas J. Kasa, USAF Lafayette, Indiana	2	0	0	28 Unmounted Immatures

Source	Number of Accessions	Adults	Slides	Other
USDA - SEL Washington, D. C.	4	2	0	7 Unmounted Adults 2 Unmounted Immatures
U.S. Army Pueblo, Colorado	1	0	0	1 Unmounted Adult
CDC Atlanta, Georgia	1	0	5	0
S. M. Smith N.W.T., Canada	1	0	0	10 Unmounted Immatures
N. Jassie, Dept. of State Tunisia, Morocco	1	0	0	3 Unmounted Immatures
Kansas State University Manhattan, Kansas	1	0	0	2 Unmounted Immatures
California State Health Dept. Sacramento, California	1	0	0	1 Unmounted Immature
S.A.I.M.R. Johannesburg, South Africa	1	0	0	6 egg lots

SUMMARY OF ACCESSIONS FROM 1 JAN 1979 TO 31 DEC 1979

57 Accessions (Numbers 736-792)

1,239	Unmounted Immatures
145	Unmounted Adults
1,762	Slides
3,914	Adults
7,060	Total Specimens

Other Material Received

6 Lots of Eggs to be Reared

Outgoing Material

81 Shipments
47 Involving Specimens

640	Unmounted Immatures
0	Unmounted Adults
2,342	Slides
1,190	Adults
4,172	Total Specimens

Other Material Shipped

50 Pill Boxes Unmounted Adults

Appendix 2

PUBLICATIONS OF THE MEDICAL ENTOMOLOGY PROJECT
Supported in whole or in part by Contract DAMD17-74-C-4086

Faran, M. E. 1979. *Anopheles (Nyssorhynchus) trinkae*, a new species in the Albimanus section (Diptera: Culicidae). Mosq. Syst. 11(1): 26-39. (March)

Peyton, E. L. and B. A. Harrison. 1979. *Anopheles (Cellia) dirus*, a new species of the Leucosphyrus group from Thailand (Diptera: Culicidae). Mosq. Syst. 11(1): 40-52. (March)

Sirivanakarn, S. 1979. A new species of *Culex (Melanoconion)* from Bolivia and Ecuador (Diptera: Culicidae). Mosq. Syst. 11(2): 135-138. (June)

Sirivanakarn, S. and W. L. Jakob. 1979. A new species of *Culex (Melanoconion)* from Southern Brazil (Diptera: Culicidae). Mosq. Syst. 11(2): 139-143 (June)

Huang, Y.-M. 1979. Medical entomology studies. XI. The subgenus *Stegomyia* of *Aedes* in the Oriental region with keys to the species (Diptera: Culicidae). Contr. Am. Entomol. Inst. 15(6): 1-79. (July)

Peyton, E. L., et. al. 1979. The biology and immature stages of *Uranotaenia (pseudoficalbia) srilankensis* Peyton (Diptera: Culicidae). Mosq. Syst. 11(3): 215-220. (September)

Huang, Y.-M. 1979. *Aedes (Stegomyia) simpsoni* Complex in the Ethiopian region with lectotype designation for *simpsoni* (Theobald) (Diptera: Culicidae). Mosq. Syst. 11(3): 221-234. (September)

Tanaka, K., K. Mizusawa and E. Saugstad. 1979. A revision of the adult and larval mosquitoes of Japan (including the Ryukyu Archipelago and Ogasawara Islands) and Korea (Diptera: Culicidae). Contr. Am. Entomol. Inst. Vol. 16, 987 p. (December)

Faran, M. E. 1979. The importance of an integrated approach in solving a problem in mosquito systematics. Mosq. Syst. 11(4): 280-8. (December)

Appendix 3

MEDICAL ENTOMOLOGY PROJECT CONSULTANTS

Dr. John N. Belkin, University of California, Los Angeles, California - New World Culicidae.

Dr. Pedro Galindo, Gorgas Memorial Laboratory, P.O. Box 935, APO Miami - New World Culicidae.

MAJ Bruce A. Harrison, Department of Medical Entomology, U.S. Army Component, Armed Forces Research Institute of Medical Sciences, APO San Francisco - Oriental *Anopheles*.

Dr. Botha de Meillon, Philadelphia, Pennsylvania.

Dr. J. M. Klein, Institut Pasteur de l'Iran, Iran - Oriental Culicidae

Professor Kenneth L. Knight, North Carolina State University, Raleigh, North Carolina - *Aedes (Finlaya)* and mosquito glossary.

Dr. Peter F. Mattingly, British Museum (Natural History), London, England - African Culicidae and *Tripteroides*.

Mr. J. Mouchet, O.R.S.T.O.M., Bondy, France - Culicidae.

LTC John F. Reinert, Research Liaison Officer, Armed Forces Pest Management Board, Gainesville, Florida - Genus *Aedes*.

Dr. John E. Scanlon, School of Public Health, University of Texas, Houston, Texas.

Dr. Shivaji Ramalingam, University of Malaya, Kuala Lumpur, Malaysia - *Topomyia, Malaya, Armigeres* and Malaysian Culicidae.

Dr. Graham B. White, London School of Hygiene and Tropical Medicine, London, England - African Culicidae.

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